



Genetic **TESTING**

**WHAT DOES
IT MEAN FOR
BREEDERS?**

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Find out what makes a good test and how to use genetic test information to better your breed.



The number of genetic tests that can be used to identify heritable disorders is increasing at an astonishing rate.

By getting involved, you will reap the reward of freedom to use any bloodline in your breed, but first you need to understand how these tests work.

Direct versus indirect testing

Not all tests available to breeders are equally accurate. Trying to sort them out and knowing how to use them can be very confusing, even for the most experienced breeder.

The gold standard for a breeding test is to have a mutation-based test. This means that the researcher has identified the exact defect in a gene of the breed that the research was carried out for. As a breeder using these tests, you need to know whether the mutation has been observed in your breed. Often a test that works well in the breed of which it was discovered is not useful in another breed.

Ask the test provider, “Is this a mutation-based test and is it validated in my breed?” You should demand the best test for your money, or at least know what you are getting.

Indirect testing is where you test a biomarker related to the trait of interest that is not based on a DNA result. Some service providers give people breeding recommendations based on indirect tests. These recommendations should be treated cautiously, since often the disorders that they are making recommendations on are complex traits. Still, if that is all →



that is available to improve a significant and common disorder, then it does have a place in your breeding program.

Simple versus complex disorders

Our genes occur in pairs. Every animal receives one gene of each pair from its mother and one from its father (unless the gene lives on the X or Y chromosomes, which are the special chromosomes that decide if we are male or female). Both humans and dogs have more than 20,000 different pairs of genes. Without exception, humans and dogs all carry some disorder genes. In fact, the average human has been found to carry around 200 of them!

Recessive genetic disorders are seen when there are two copies of the same broken gene (one from each parent). These disorders are known as simple or Mendelian recessive genetic disorders. Dominant Mendelian disorders require

only one gene to be abnormal for the disorder to occur. Dominant disorders are less frequently seen, because we can readily remove the disorder by not breeding from the affected animal. Sometimes though, the disorder may not show up until the animal has finished its breeding life – and these do tend to persist. An example of this kind of disorder is one that does not affect the dog until it is nine or 10 years old, and by this time its offspring may have also bred. These disorders are typically much harder to create a genetic test for than the recessive disorders, because more samples from animals with the disorder are needed to find the gene responsible.

Complex disorders are those that are affected by lots of different genes and the environment. Examples of complex disorders are autoimmune disorders, heart disease, elbow dysplasia, hip dysplasia and cancer. Even when researchers are able to identify some of

the genes underlying these conditions, it is difficult to make a firm breeding recommendation based on the genetic testing information. Developing the tests to identify the ‘risk’ genes in these disorders is much more difficult and time consuming. When lots of genes affect risk, it’s a bit like playing poker – your pup may be dealt a good hand or a bad hand from the larger deck of genes.

Rather than using a series of DNA-based genetic tests, breeding decisions regarding complex disorders are typically based on the dog’s own phenotype, such as radiographic or clinical test results. Usually, having this information for a single breeding dog explains less than 25 per cent of what will be observed in the offspring. However, you can understand the risk of producing pups with the disorder better by looking at the wider testing results for the whole families of the sire and the dam. There is an international

movement afoot to make this kind of analysis more accessible to breeders. We call these family-based scores estimated breeding values (EBVs). In the near future, this will be the best option for tackling complex traits. It is likely that hip scores will be among the first disorders to have estimated breeding values available. You can help this movement by encouraging your breed organisation to get involved.

Avoiding bloodlines with genetic disorders versus breed diversity

You may wish to breed into a bloodline that is known to suffer from a genetic disorder. In this case, it is wise to test for the disorder if there is a genetic test available. This will enable you to choose safely from within the bloodline.

Our understanding of the frequency of disorder genes in all animals, including humans, has changed quite a lot in the past few years. Once upon a time, genetic test providers would tell you that a dog with a carrier status for a recessive genetic disorder should not be bred. We no longer believe that to be the best decision. The modern view is that we should not exclude dogs from the gene pool based on a carrier result for a genetic test. Instead, breeders should use the test to make sure that they breed their carrier dog with a non-carrier mate. In this way, dogs can be bred without the disorder showing up in the offspring. The breeder can then test potential offspring to try to keep a 'clear' or 'normal' breeding replacement animal as soon as is practical. In the meantime, the breeder can ensure that one 'clear' animal is used for every DNA test in every breeding pair.

The reality is that forcing people to use animals that are clear for every test will place unnecessary pressure on the clear animals and may result in popular sires. The latest research tells us that the damage done to the population by overusing a single popular animal is far worse than the damage done from breeding a carrier animal to a normal mate.

Similarly, avoiding breeding into bloodlines that are known to express a genetic disorder prevents the breed from benefiting from the outstanding qualities and extra genetic diversity that this bloodline may offer. If a test is available, then there is no need to avoid using that bloodline.



Genetic tests can be used to ensure carriers of recessive genetic disorders are bred with non-carriers.

Some registries such as the Orthopedic Foundation for Animals in the USA offer 'clear by parentage' certification. To get this, both parents in a registered litter need to have certification showing that they have clear or normal genetic status for a particular disorder. The pup from such a litter will also be awarded clear by parentage status for breeding purposes. If a true 'clear' result is obtained, and this dog or bitch is only ever bred with other clear animals, then a Mendelian disorder should never re-appear. If it does, this implies one of two things - a mistake in a test result, or an inaccuracy in the pedigree. ...

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Using genetic test information

Your decision to make use of a test will be affected by many things. If you are part of a breed community, there may be a group decision as to what tests should be applied. The things that should influence your decision should be things like:

- Efficiency of the test
- Severity of the disorder
- Age of onset
- Frequency of the disorder in the breed
- Cost of the test

The age of onset is a prickly one. People often refer to some lethal genetic disorders that occur around the time of birth as a 'breeder problem'. If the pup succumbs before eight weeks, this is regarded as better than if the pup is sent home with a new family before it becomes ill. While this is true on an emotional level, it is not really justifiable on either animal welfare or economic grounds. Each pup that you lose is costing you the sale price of that pup and this can be considerable. While a recessive disorder is expected to affect only a quarter of the pups born to two carrier parents, it may sometimes mean the loss of the entire litter. If at least one parent is clear of the recessive disorder (not a carrier), then no pups will have the disorder.



If you are part of a breed community, it may be a group decision as to the genetic tests used.